Results of the El Trébol Landfill Landfill Gas Pre-Feasibility Study

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LANDFILL METHANE OUTREACH PROGRAM

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Presentation Topics

- **Introduction**
- **Proposed landfill gas collection, control, and utilization systems**
- **Evaluation of project costs**
  - Collection and flaring system costs
  - Electricity generation (power plant) project costs
  - Direct use project costs
- **Economic evaluation**
- **Methane emission reduction estimates**
- **Conclusions**

Introduction

- **Objective of study is to evaluate technical and economic feasibility of LFG utilization projects:**
  - Electricity generation (power plant) project
  - Direct use projects
- **LFG recovery estimates indicate either type of project is technically feasible using collection and utilization systems described in this presentation**
- **Economic feasibility evaluated by comparing system construction and operating costs with project revenues**

Proposed LFG Collection System

- **40 vertical extraction wells to collect LFG**
  - Well design similar to pump test wells
  - Well depth varies with refuse depth
  - Lower 1/2 to 2/3 consist of perforated piping
  - Well spacing based on ROI estimates: ~1 well per acre (0.4 hectares)

Proposed LFG Collection System

- **Approximately 4500 m of HDPE piping**
  - Piping connects the extraction wells with the flare station and electricity-generating plant or compressor station (for direct use project)
  - Includes main header and smaller lateral piping

Proposed LFG Collection System

- **Leachate collection system**
  - Moisture percolates through trash and forms leachate that accumulates in extraction wells.
  - Pumps need to be installed in extraction wells to pump out liquids
- **Condensate management system**
  - Condensate is liquid which forms in the piping network as the warm, moist gas cools
  - Condensate is collected in condensate traps and pumped out

Proposed Flare Station

- Flare station is needed to ensure that all collected LFG is combusted when utilization facilities are not operating

Proposed Flare Station

- **Flare station components:**
  - Enclosed flare with a 1,500 ft^3/minute (2,550 m^3/hour) capacity (based on maximum projected gas flows)
  - Blower(s) for applying vacuum to the well field
  - Flow control valves, measuring and recording equipment

Proposed Electricity Generating Plant

- **2.12 MW (gross) capacity power plant**
  - Includes two 1.06 MW internal combustion engines, measuring and recording equipment
  - Requires 754 ft^3/minute (1,282 m^3/hour) LFG to operate
  - Can increase plant size in future as more LFG becomes available
  - Economic analysis assumed no increase above 2.12 MW

Proposed Direct-Use Project

- **Deliver LFG via pipeline to a possible end-user:**
  - Plastics recycling plant (Ecoplast) located adjacent to the landfill or
  - Brewery located 2 miles from the landfill
- **Facilities for direct-use project include:**
  - Gas filter, compressor, and de-hydration unit at the landfill
  - 0.2 mile (estimated) pipeline to deliver LFG to Ecoplast plant
  - 2 mile pipeline to deliver LFG to brewery
  - Design flow = 789 ft^3/minute (1,341 m^3/hour) = 24 mmBtu/hour based on projected 2007 LFG recovery

Collection and Flaring System Costs

- **Construction cost estimate: $1,761,400***
  - Costs cover items shown previously
  - Additional cost items covered include: mobilization; project management; emissions testing; engineering contingency; and costs of registering project for emission reductions
- **Annual operating and maintenance cost estimates*:**
  - $176,000 for operation and maintenance of wellfield and flare station
  - $41,000 for new wells and piping (assumes 2 wells/year while landfill is operating)
  - $30,000 for registering, monitoring, and verification of emission reductions

***All cost estimates are in 2005 U.S. $ and do not include inflation**

Power Plant Project Costs

- **Construction cost estimate: $3,264,400***
  - Costs cover items shown previously
  - Additional cost items covered include: mobilization; plant construction/site work; project management; emissions testing; engineering contingency; and electrical interconnection
- **Annual operating and maintenance cost estimate: $280,000***
  - Covers power plant operations and maintenance, including: labor, testing equipment and parts, routine maintenance and repairs, minor equipment replacement.

***All cost estimates are in 2005 U.S. $ and do not include inflation**

Direct Use Project Costs

- **Construction cost estimate: $950,000***
  - Costs cover items shown previously plus engineering contingency
- **Annual cost estimate for operating and maintaining compressor station and pipeline: $100,000***

***All cost estimates are in 2005 U.S. $ and do not include inflation**

Project Revenues

- **Project revenue sources include:**
  - Sales of emission reductions from methane combustion
  - Potential electricity sales from power plant project

  - Potential sales of LFG to end-users for direct use project

Economic Evaluation

- **Assumptions for collection and flaring system:**
  - Evaluation covers 15 year period of 2006 – 2020
  - Collection system and flare operational starting July 2006
  - Includes two financing options:
    - **No financing (100% initial application of capital expense)**
    - **75% financing (25% equity investment)**
  - Two scenarios for pricing of emission reductions:
    - **$5 per CO_2 equivalent tonne**
    - **$6 per CO_2 equivalent tonne**
  - Interest rate = 8% (applies to both loan financing and NPV analysis)

***All estimates are in 2005 U.S. $**

Economic Evaluation

- **Assumptions for collection and flaring system:**
  - Initial capital investment for facility construction incurred in 2006
  - Loan payback period = 10 years
  - Payment to the landfill owner for LFG = $0.35/mmBtu, with a 3% annual increase
  - Operating and maintenance costs increase 3% annually

- Access to most of landfill for wellfield development assumed

***All estimates are in 2005 U.S. $**

Economic Evaluation

- **Power plant project assumptions:**
  - 2.12 MW plant will operate 2007 – 2020
  - 7% parasitic load; 90% capacity factor
  - All electricity generated is sold off-site at an initial price of $0.06/kWhr, with a 3% annual increase
- **Direct use project assumptions**
  - Two projects will operate 2007 – 2020
  - Requires 2.2 miles of pipeline
  - 90% capacity factor
  - Approximately 189,000 mmBtu/year is sold to the end users at an initial rate of $5/mmBtu, with a 3% annual increase

***All estimates are in 2005 U.S. $**

Economic Evaluation

- **Power plant project evaluation results:**

Emission Reduction Price ($/tonne)	Equity Investments (%)	Net Present Value (x1000 $)	Internal Rate of Return (%)
5	100	$851	11.5%
6	100	$1,345	13.7%
5	25	$711	15.8%
6	25	$1,205	22.7%

***All estimates are in 2005 U.S. $**

Economic Evaluation

- **Direct use project evaluation results:**

Emission Reduction Price ($/tonne)	Equity Investments (%)	Net Present Value (x1000 $)	Internal Rate of Return (%)
5	100	$4,645	37.3%
6	100	$5,109	41.4%
5	25	$4,570	91.6%
6	25	$5,034	108.3%

***All estimates are in 2005 U.S. $**

Economic Evaluation

- **Summary of project evaluation results:**
  - Both power plant and direct use projects have favorable economics – strongly positive estimates of net present value (NPV) and internal rate of return (IRR)
  - Direct use project has higher NPV and IRR estimates than power plant project
    - Direct use found more economically favorable mainly due to much lower project investment and maintenance costs

Economic Evaluation

- **Economic evaluation very sensitive to electricity and gas sales price assumptions**
  - Electricity sales price of $0.06/kWhr based on average wholesale electricity price in Guatemala in July 2005
  - Gas sales price of $5/mmBtu based on limited data – need information on energy costs from end users

Methane Emission Reductions

- **Estimate a total of 1,566,746 tonnes of CO_2-equivalent methane emission reductions for project period (2006 – 2020)**

Year	Tonnes CO_2e	Year	Tonnes CO_2e	Year	Tonnes CO_2e
2006	38,121	2011	97,750	2016	119,543
2007	80,693	2012	101,992	2017	124,143
2008	85,031	2013	106,276	2018	128,853
2009	89,297	2014	110,623	2019	149,419
2010	93,525	2015	115,040	2020	126,440

Power Plant Project Environmental Benefits

- **Benefits (from methane combustion and from displacing conventional energy sources) are equivalent to any one of the following:**
  - Removing emissions equivalent to 16,470 cars;
  - Planting 22,250 acres of forest;
  - Offsetting the use of 370 railcars of coal;
  - Preventing the use of 175,200 barrels of oil; or
  - Powering 1,400 homes per year.

Direct Use Project Environmental Benefits

- **Benefits are equivalent to any one of the following:**
  - Removing emissions equivalent to 18,530 cars;
  - Planting 25,000 acres of forest;
  - Offsetting the use of 415 railcars of coal;
  - Preventing the use of 197,000 barrels of oil; or
  - Heating 5,740 homes per year.

Conclusions

- LFG utilization project is technically and economically feasible with either a 2.12 MW power plant project or a 189,000 mmBtu/year direct use project
- Both projects were evaluated for a 2006 – 2020 project period and were found to have positive NPV and IRR estimates – direct use higher
- Recommend refinement of direct use project revenues based on information on energy costs for potential end-users

Questions?

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